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@#####ýý##ä#G}#####r##Zð=øF
##ýý ###ýý#####ýýd#####d#####Æ###The CRIMS1 Relative Risk Weighting
(RRW) Process# Simplified #(No Analytical Hierarchy Process)##1997 SSCAG FALL
MEETING##David R. Graham#16 OCT 1997##1Cost-Risk Identification and Management
System

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óûÿÿ,###ÿÿ#####ÿ[]#ÿÿd#####d#####\$###TOPICS#RELATIVE RISK WEIGHTING (RRW)

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#####d#####±###CRIMS OverviewThe Need for the
Simplification of the RRWhy Relative Risk Weighting?The Simplified RRW:
Steps 1-4A Spacecraft WBS ExampleWhy RRW WorksRRW Matrix Summary

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,#####ÿÿd#####d#####2##Zöíùv
3#ÿÿ####ÿÿ####ÿÿd#####d#####G###Identify cost-risk with the Relative
Risk Weighting Process (RRW)Use Weighted Risk Category, Scaled Matrix with
Engineering Input to Develop and Apply Relative Risk Ratios for WBS Element
Level Triangular DistributionsCombine RRW Distributions with Cost Estimating
Cost-Risk Distributions Using Monte Carlo SimulationsTrack cost-risk with the
Risk Feedback Management Strategy (RFMS)IBR and Earned Value; TPMs, Technical
Interchanges Store cost-risk with Cost Risk DatabaseActual Cost Results Compared
to ExpectationsCalibration Factor Development for Cost Proposal EvaluationC

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#####d#####t###The main point to CRIMS is expressed by the acronym ITS - Identify, Track and Store. The preferred methodology for identification within CRIMS is the Relative Risk Weighting process where three technical risk profiles of a WBS element are scored and the scores used to develop ratios that are applied to the point estimate as multipliers to generate the high and low ends of a triangular distribution. Monte Carlo simulation is used to combine these distributions into a summary distribution from which a cost is selected for budgeting at some confidence level. After contract award, the govt and contractor work together in managing the cost-risk with the help of the earned value management system of the contractor. After the contract is over, initial estimates are compared with actuals and lessons learned are stored in a database for future evaluation and projections.

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Need for the Simplification

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relative to the instances of like-WBSs that have been developed before
Pessimistic and Optimistic profiles are relative to what is expected, that is,
to the [Reference] profileThe RRW process takes both relativities into account

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súÿÿ,###ÿÿ#####ÿ□#ÿÿd#####d#####The Relative Nature of the RRW

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sÿÿ ###ÿÿ#####ÿÿd#####d#####m###All profiles are rated relative to
the CARD or some other technical descriptionOnce all three profiles are rated
and a risk [score] is obtained for each, ratios are developed between the
Pessimistic and Optimistic scores and the Reference scoreThese ratios become
factors applied to the Reference cost to derive the low and high ends of a
triangular distribution #

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Y#ÿÿ####ÿÿ#####ÿ[]#ÿÿd#####d#####Reference Cost

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ù#pÿÿ####ÿÿ####ÿ#ÿÿd#####d#####Pessimistic Profile

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####Optimistic Profile

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#####Reference Profile

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Pess/RefRRW Ratio

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Opt/RefRRW Ratiot

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#####Equivalent Cases

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Note: The Reference Cost is
actually not a point but a distribution of point costs, to which RRW ratios are
applied during the simulation i

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Applied Ratios

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Works

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AHP or Expert Choice #

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C#ÿÿ#####ÿÿÿÿd#####d#####ÿÿSTEP 1: Choose Risk Categories and
Directly Assign Weights of Relative ImportanceSTEP 2:Directly Assign Values for
Rating Intensities in Each Risk Category Rating ScaleSTEP 3: Using Scale
Values, Rate the WBS's Three Profiles Against Risk CategoriesSTEP 4: Develop
the Cost-Risk Factors (Ratios) between Pessimistic/Reference and
Optimistic/Reference Risk Scores to apply to the Reference cost estimate

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Spacecraft WBS Examples

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#####2##[]##^aöüV c#ÿÿ####ÿÿ#####ÿ#ÿÿd#####d#####ë###Example: A New
Spacecraft Has to be Evaluated for Cost-Risk Step 1: Work
with engineers to assign weights, that sum to 1.0, to each example risk
category: TECHNOLOGY 0.35DES/ENG 0.25COMPLEXITY 0.2 SCHEDULE
0.2 1.0#

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Cúÿÿ,###ÿÿ####ÿ#ÿÿd#####d#####>###Directly Develop Scale Values:#A
Spacecraft WBS Example (cont)

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 assign weights to rating intensities for each scale by risk category:

	TECH	DES/ENG	COMPLEXITY	SCHEDULE	Very Low	0.8
0.7	0.9		0.6	Low	1	1
1	1	Mod Low	2	2.5	2	1.5
Moderate	3	3.5		2.7	2.2	Mod High 4
4.5	4		3.8	High	5	6
5.5	5.3	Very High	6.5	7.5	6	6.3ø

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#A Spacecraft WBS Example (cont)

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ó### #####ÿ#ÿÿd#####d#####Step 3: TECH DES/ENG
COMPLEXITY SCHEDULE TOTAL RISK (0.35) (0.25) (0.2)
 (0.2) SCOREPessimistic High VH VH HIGH
 Profile (5) (7.5) (6) (5.3) 5.9
Reference MOD MOD MOD MOD Profile (3) (3.5)
 (2.7) (2.2) 2.9 Optimistic LOW ML MOD
MOD Profile (1) (2.5) (2.7) (2.2) 2.0Ref
Profile Calc: (0.35)(3) + (0.25)(3.5) + (0.2)(2.7) + (0.2)(2.2) = 2.9P

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WBS Example (cont)

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f \ddot{y} ##### \ddot{y} \ddot{y} \square \ddot{y} d#####d##### \ddot{o} ###Step 4: Build
Pessimistic/Reference Profile and Optimistic/Reference Profile Ratios
Pess/Ref = 5.9/2.9 = 2.00pt/Ref = 2.0/2.9 = 0.7Factors are applied to the
Reference cost for low and high of distribution

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COST) 2.0 * RPE(HIGH END

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PESSIMISTIC PROFILE HIGH VERY HIGH VERY HIGH
HIGH 5.92. REFERENCE PROFILE MOD MOD MOD MOD 2.93.
OPTIMISTIC PROFILE LOW MOD LOW MOD MOD 2.0

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###ÿÿ#####ÿ[]#ÿÿd#####d#####8###WBS ELEMENT PROFILES 0.35
0.25 0.2 0.2 1.0

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Spacecraft WBS Example (cont)

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úÿÿö#s ÿÿ####ÿÿ#####ÿ#ÿÿd#####d#####²###Since, in most cases, the
best information we have is low, most likely and high estimates (or can credibly
develop), a triangular distribution is used (bottom of chart). The development
of the low and high ends of the triangle are the result of factors applied to
the government point cost estimate (GPE). A risk category matrix (top of chart)
is developed utilizing risk categories and weighted using the Analytical
Hierarchy Process (AHP), a purely mathematical technique for generating valid,
ratio-level (vice ordinal-level) weights. The AHP is also used to weight the
Very Low to Very High scales. Three profiles of the WBS element are rated
against the weighted risk categories using the weighted scales and three risk
scores are generated representing how risky each is perceived to be by the
raters, mostly engineers. Two ratios are developed from these three risk scores
and used as factors on the point cost estimate (assumed to be the most likely in
the triangle) to generate the low and high ends of the triangular distribution.
Since the CARD specifications are rated for the Reference Profile and result in
the Reference Profile risk score and the CARD specifications result in the
Reference Point cost estimate for that WBS element, there is an implied
equivalency between the Reference Profile risk score and the Reference Point
cost estimate. In other words, the Reference Profile risk score represents the
WBS in qualitative, technical risk form. The Reference Point cost estimate
represents the WBS in cost form. It is this equivalency that justifies the
application of the ratios to the point cost estimate that generates the upper
and lower bounds of the cost-risk triangle.

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3#ÿÿ####ÿÿ####ÿÿd#####d#####G###Identify cost-risk with the Relative
Risk Weighting Process (RRW)Use Weighted Risk Category, Scaled Matrix with
Engineering Input to Develop and Apply Relative Risk Ratios for WBS Element
Level Triangular DistributionsCombine RRW Distributions with Cost Estimating
Cost-Risk Distributions Using Monte Carlo SimulationsTrack cost-risk with the
Risk Feedback Management Strategy (RFMS)IBR and Earned Value; TPMs, Technical
Interchanges Store cost-risk with Cost Risk DatabaseActual Cost Results Compared
to ExpectationsCalibration Factor Development for Cost Proposal Evaluation#

#####d#####t###The main point to CRIMS is expressed by the acronymn ITS - Identify, Track and Store. The preferred methodology for identification within CRIMS is the Relative Risk Weighting process where three technical risk profiles of a WBS element are scored and the scores used to develop ratios that are applied to the point estimate as multipliers to generate the high and low ends of a triangular distribution. Monte Carlo simulation is used to combine these distributions into a summary distribution from which a cost is selected for budgeting at some confidence level. After contract award, the govt and contractor work together in managing the cost-risk with the help of the earned value management system of the contractor. After the contract is over, initial estimates are compared with actuals and lessons learned are stored in a database for future evaluation and projections.

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###ÿÿ####@ÿ#ÿÿd#####d#####n###Manage only KPP and Significant Risk The
better the performance--the less tracking/reporting there should be

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i#####ÿ#ÿÿd#####d#####S### 1. Earned value insight (BCWS,
BCWP, ACWP on Format 1 and narrative status on Format 5) for the following high
risk WBS elements shall be provided every month regardless of variance
percentage levels until the system program office (SP0) informs the contractor
otherwise: (List High Risk WBS Elements here) If WBS elements, other than
those identified here, begin to experience variances exceeding 10% due to
technical risk for two consecutive months, the contractor will inform the
Program Manager and a consensus reached on adding them to the group of high risk
WBS elements identified for monthly cost performance reporting and analysis
purposes. All other WBS elements shall have earned value (BCWS, BCWP,
ACWP) reported at level 3 of the WBS to satisfy observing and monitoring
requirements according to acquisition reform guidelines.#

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ÿd#####d#####2###Earned Value CDRL Special InstructionsParagraph 1

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#ýý####ýý#####ý[]#ýýd#####d#####2. The contractor shall, at least annually, re-assess the cost-risk on the contract, developing a cumulative distribution function (CDF) that reflects the degree of cost-risk variance at the total contract level at that time, using the same methodology as that used to develop the proposal CDF, i.e., CRIMS. Using the same cost-risk determination methodology ensures continuity and consistency for equivalent traceability purposes to the proposal CDF and subsequent CDFs for the effort. The CDF will be a build-up of high risk WBS cost distributions plus all other costs and distributions (if any), and will provide the rationale and assumptions for CPR Blocks 6 a and b (Best Case and Worst Case). Explanations of changes will be provided in Format 5 for program management documentation.

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InstructionsParagraph 2

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Value and Cost-Risk

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ó#ÿÿ#####ÿÿd#####È###Use of earned value as early warning
system for possible CAIV cost/performance trades Focus EVMS and reporting on
high risk WBSs that might overrun in meeting requirements Estimates-at-
completion (EAC) show trendsOver-budget trends direct program management
attention to opportunities for cost/performance trades Cost-risk reduction
metric: Periodic cost-risk distribution updates for award fee determination
Illustrates IPT consensus on risks reduced

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#####d#####At nine months after contract award the Integrated Baseline Review (IBR) has taken place and we can begin to really trust the data. We are seeing some cost growth (overrun in this case) which should flag the project managers that some cost/performance trades are in order.

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The real situation we are in now is depicted in the accompanying chart. Somewhere between the 50% confidence level cost and the point estimate is where the "affordability target" lies. Whatever confidence level is associated with that cost is the confidence level to which the program managers have to convince the decision makers they can manage. They must be able to explain the risks they have identified, the plans they have to prevent or, at least, mitigate the risks and cost-risk possible, and demonstrate that they have a structured system for credibly tracking the cost-risk effects of risk prevention and risk mitigation. This monitoring system cannot prevent risks from occurring but may enhance the implementation of risk mitigation plans and, at least, will give indications of possible estimates at completion if trends identified continue. By identifying the possible cost impacts of risks being realized, project officers will be more motivated to implement risk mitigation or perhaps change the direction of the mitigation if the present path appears too costly. The recognition of cost impacts will serve as a focusing mechanism to take action.

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with second award fee determination)#

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End of Contract Cost-Risk Distribution#

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At the 36 month point, and another award
fee determination point, another RRW is performed confirming that the contractor
is indeed lowering the risk. The EAC is consistently lower than the AC0.

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üy####y####@y#y#d#####d##### ###Proposal #

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###Mid-Contract

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###@ÿ#ÿÿd#####d#####1##ÿ#ÿ#ÿ#ú[#¹úÿÿ####ÿÿ####@ÿ#ÿÿd#####d#####
#####Near End-of-Contract

#####@#d#####1##"öÅp
ø#y####y####@#d#####Confidence Level

#####@ÿ#ÿÿd#####d#####

###@ÿ#ÿÿd#####d#####1##Büæ#ÿó#ÿÿ####ÿÿ####@ÿ#ÿÿd#####d#####
#####Cost \$B#

#####@ÿÿd#####d#####1##âì#M
#ÿÿ####ÿÿ####@ÿÿd#####d#####Actual

#####@ÿ#ÿÿd#####d#####1##Rõú8
ýûÿÿ####ÿÿ####@ÿ#ÿÿd#####d#####Contract End - 3rd RRW #

#####@ÿ#ÿÿd#####d#####1##Rõn##
úu#ÿÿ####ÿÿ####@ÿ#ÿÿd#####d#####7###Could Have PickedThis Low
ConfidenceLevel Initially!!#

#7#####7#####7#####@ÿ#ÿÿd#####d#####@ÿ#ÿÿd##
#####d#####@ÿ#ÿÿd#####d#####1####P#(#å#ÿÿ####ÿÿ####@ÿ#ÿÿd##
#####d##### "### Contract Target Cost

#####³üÿÿ(#####ÿ#ÿÿd#####Actual At Completion

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At the end of the effort the actual is lower than the ACO - a very good result. Our initial budget, identified at the 50% mark by tradition, is now seen as too conservative. This is also a good sign for the long term (not so good perhaps for the PM who ended up with too much money at the end, however) and means that acquisition reform is working, resulting in more programs for limited TOA. It appears that the program manager could have been much more aggressive in being a risk manager due to the actual final cost, overlayed on the original S-curve, being at about the 12% confidence level. This indicates empirically that AF managers can bring in programs at lower than 50% budgets, ensuring that scarce dollars be stretched further successfully. #

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g#ýý####ýý#####ý#ýýd#####d#####â###3. For program management purposes
and cost calibration purposes, the contractor shall classify all cost growth as
either [risk-driven cost growth] or [externally-driven cost growth] in format 5.

[Risk-driven cost growth] (RDCG) is cost growth, overruns or funded
changes, linked to technical risk categories originally used to identify cost-
risk in the cost estimate (e.g., technology, complexity, schedule,
design/engineering, manufacturing, integration, etc). [Externally-driven
cost growth] (EDCG) is cost growth, overruns or funded changes, linked to
external factors (e.g., requirements changes, technical enhancements not driven
by risk, perturbations to budgets by AF, OSD or other agencies causing schedule
changes, etc.).

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#2###Earned Value CDRL Special InstructionsParagraph 3

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RDCG + EDCG = ECCnew (=150)B

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Govt RPE(from Govt models)

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#d#####BCC + RDCG + EDCG =
ECCold(100) (40) (60) = (200)

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####With Acq Reformb

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3p# #d##### Acquisition Reform Cost Savings#
- RDCG and EDCG Should Be Much Lower in# the Future Due to
Acquisition Reform # Implementation#

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Ç#ýý####ýý#####ý□#ýýd#####d#####G###4. In order to ensure that CAIV requirements are fulfilled with respect to meeting minimum performance/operational thresholds, the contractor shall identify WBS elements whose development determines Key Performance Parameter (KPP) levels. This KPP/WBS information is essential to provide cost projections that may indicate opportunities for cost/performance trades. The definitions for KPPs shall be consistent with like-parameters contained in the Acquisition Program Baseline and the Operational Requirements Document. If KPPs are added during the contractual effort, any WBS elements determining their status will also be identified. When performance measurement information indicates that KPP projected costs will require trade-offs to be evaluated, this information will be included in Format 5 as part of Total Program Analysis.#

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InstructionsParagraph 4

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#øÿÿ####ÿÿ####ÿ#ÿÿd#####d#####KPP/WBS POINTER MATRIX

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ùÿÿ,###ÿÿ#####ÿ[]#ÿÿd#####d#####CRIMS#

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,#####ÿÿd#####d#####2##Zöúv
c#ÿÿ####ÿÿ####ÿÿd#####d#####î###Identify with the Relative Risk
Weighting Process (RRW)Use Weighted Risk Category, Scaled Matrix with
Engineering Input to Develop Technical Cost-Risk Distributions at WBS Element
LevelCombine Distributions Using Monte Carlo SimulationsTrack with the Risk
Feedback Management Strategy (RFMS)IBR and Earned Value; TPMs, Technical
Interchanges Store with Cost Risk DatabaseActual Cost Results Compared to
ExpectationsAC, TC, BC RC, E1, E2 & E3 Calibration Factor
Development

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úÿö#s ÿÿ

#####ITS#####The main point to CRIMS is expressed by the acronym ITS - Identify, Track and Store. The preferred methodology for identification within CRIMS is the Relative Risk Weighting process where three technical risk profiles of a WBS element are scored and the scores used to develop ratios that are applied to the point estimate as multipliers to generate the high and low ends of a triangular distribution. Monte Carlo simulation is used to combine these distributions into a summary distribution from which a cost is selected for budgeting at some confidence level. After contract award, the govt and contractor work together in managing the cost-risk with the help of the earned value management system of the contractor. After the contract is over, data is analyzed, calibration factors developed, initial estimates are compared with actuals and lessons learned are stored in a database for future evaluation and projections.

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Phase of CRIMS:#Cost-Risk Database (CRDB)ÿ

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s#####
BCCs, RDCG, EDCG, ECCs, GRPEs, AC, E1, E2 & E3, TC, BC & RC Calibration Factors
for SMC ProgramsThe Calibration Factors Will be Used on Upcoming, Acquisition
Reform Era Programs

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óúýý,###ýý####ý#ýýd#####d#####Cost-Risk Database

,#####ÿÿd#####d#####2##Zöûv
Óÿÿ####ÿÿ####ÿÿd#####d#####(###Contains Technical and Cost-Risk
AssessmentsContains Actual Technical and Cost Data at CompletionCompares History
of Original Assessments versus ActualsAugments Past Performance Analysis in
Source SelectionsAllows Lessons Learned for Next AcquisitionDerivation and use
of Calibration Factors

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Óúÿÿ,###ÿÿ#####ÿ□#ÿÿd#####d#####'###Anticipating Acquisition Reform
Savingsÿ

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#####Z###Need a Method to Predict SavingsNeed
a Calibration of Govt RPECRIMS Provides the Means by Tracking Cost Growth
CarefullyCan Calculate the Acquisition Reform Effects Calibration Factor ACBy
Identifying RDCG and EDCG, can Calculate Calibration Factors for Budgeting and
Source SelectionTC, BC RC, E1, E2 & E3 Calibration Factors

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£úÿÿ,###ÿÿ#####ÿ#ÿÿd#####d#####2###Acquisition Reform Effects
Calibration Factor (AC)

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Reform End-of-Contract CostsECCnewNeed Govt Cost Model EstimateGRPEECCnew/GRPE =
ACe.g., With Acq Reform ECC = 150 & GRPE= 200AC = 150/200 = 0.75TASC/Coopers &
Lybrand AR Cost Study AC = 0.8317% Acquisition Costs Due to Govt Oversight

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ã#ÿÿ,###ÿÿ#####ÿ[]#ÿÿd#####d#####5###CONTRACTOR ACQUISITION REFORM
CALIBRATION FACTOR (RC),

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+ RDCG (=RC*RPE)

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ý####ý#####@#ydd#####d##### Govt RPE (Cost Model Output) #

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 ãùÿÿ,###ÿÿ#####ÿ#ÿÿd#####d#####RC Calibration Factor#

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3#ÿÿ####ÿÿçÿ###ÿ#ÿÿd#####d#####!###The RC is the Combination of
Two CalibrationsACRisk Empirical Acquisition Reform Calibration Factor E3The
Combination of the AC and the E3 Equals the RCAC*E3 = RC

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Óúÿÿ,###ÿÿ#####ÿ#ÿÿd#####d##### ##PURPOSE OF E3 CALIBRATION FACTOR

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Contractor Has to Budget for Risk-
Driven Cost GrowthGovernment Has to Verify Contractor Estimates of RDCGThe E3
Factor is Used to Calibrate the Government RPE, Adjusted by the AC, into a
Number Equivalent to BCC Plus an Empirically Derived Amount for RDCGProvides
Government Evaluators with an Empirical Foundation for Verification of
Contractor Risk Estimatest

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##ÿÿ#####ÿ#ÿÿd#####!###E3 Cost Factor Derivation:There is a
Number Z such that Z Times the End-of-Contract Cost (ECC) Equals the Bid
Cost Plus RDCGECC*Z = Bid Cost + RDCGThere is Also Another Relationship:ECC -
EDCG = Bid Cost + RDCGTherefore, ECC*Z = ECC - EDCG; which leads to,
Z = ECC-EDCG ECC Z = Risk Empirical
Acquisition Reform Factor E3 RC = AC*E3

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Sùÿÿ,###ÿÿ#####ÿÿd#####d#####RC Use

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c#yy####yy####y#ydyd#####d#####The Govt RPE is the Initial Estimate
of the ECCBased on non-Acquisition Reform Era ProgramsApplying the AC andE3 to
the Govt RPE then Gives us an Estimate of BCC plus RDCG (= 120), the Acquisition
Reform Risk Coste.g., AC = 0.75; E3 = (ECC-EDCG)/ECC
E3 = (150-30)/150) = 120/150 = 0.8RC
= 0.75*0.8 = 0.6RC*GRPE = 0.6*200 = 120Use Acq Reform Risk Cost to Compare to
the Contractor MPC for a Risk Crosscheck in the Acquisition Reform Era#

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Ãûÿÿ,###ÿÿ####ÿÿ#ÿÿd#####d#####Cost-Risk Database (CRDB)#

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sÿÿ ###ÿÿ#####ÿÿd#####The Third Phase of CRIMS is
the CRDBCRDB Will Contain Records of BCCs, RDCG, EDCG, ECCs and GRPEs for SMC
ProgramsFrom those Records the AC, E1, E2 & E3, TC, BC & RC Calibration Factors
Will be derived and Used on Upcoming, Acquisition Reform Era Programs #

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###3#####Ê#####Ö#####P#####Ç###The CRIMS1 Relative Risk Weighting
(RRW) Process Simplified (No Analytical Hierarchy Process) 1997 SSCAG FALL
MEETING David R. Graham 16 OCT 1997 lCost-Risk Identification and Management
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Â#úö.###Cost-Risk Identification and Management
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